

A comparison of four algorithms in the alignment of plantar pressure images

Francisco P. M. Oliveira¹, João Manuel R. S. Tavares²

¹ Faculdade de Engenharia da Universidade do Porto (FEUP) / Instituto de Engenharia Mecânica e Gestão Industrial (INEGI), Rua Dr. Roberto Frias, 4200-465 Porto, Portugal, email: francisco.oliveira@fe.up.pt

² Faculdade de Engenharia da Universidade do Porto (FEUP), Departamento de Engenharia Mecânica (DEMec) / Instituto de Engenharia Mecânica e Gestão Industrial (INEGI), Rua Dr. Roberto Frias, 4200-465 Porto, Portugal, email: tavares@fe.up.pt

Abstract: Four distinct algorithms were study in the alignment of plantar pressure images: one is based on the matching of the feet external contours, another uses the technique of phase correlation, a third directly optimizes the cross-correlation and takes advantage on the fast Fourier transform properties, and a last one iteratively optimizes an intensity (dis)similarity measure. The later algorithm implements a two-steps approach: firstly, an initial alignment is accomplished by one of the former algorithms; then, the alignment is enhanced by optimizing a selected image (dis)similarity measure via Powell's method.

Two kinds of tests were performed to assess the alignment accuracy: 1) a set of known control geometric transformations was applied to the testing images, and the residual errors were computed from the spatial positions of the aligned and transformed pixels. 2) 30 pairs of real plantar pressure images were aligned, and the mean squared error (MSE) and mutual information (MI) measures were evaluated.

Regarding the accuracy obtained in the alignment of the images transformed by the control geometric transformations, the algorithm based on the iterative optimization achieved the best result ($p < 0.001$), closely followed by the algorithm based on the direct optimization of the cross-correlation in the frequency domain and the algorithm based on the phase correlation technique. The same performance was observed in the alignment of the 30 pairs of real images. In terms of computational speed, the algorithm based on the matching of contours was the fastest, and the algorithm based on the iterative optimization the slowest.

Keywords: Plantar pressure, Image alignment, Matching, Optimization, Fourier transform.

Acknowledgements

This work was partially done under the scope of the research projects with references PTDC/EEA-CRO/103320/2008, UTAustin/CA/0047/2008 and UTAustin/MAT/0009/2008, financially supported by Fundação para a Ciência e a Tecnologia in Portugal. The first author would like to thank Fundação Calouste Gulbenkian in Portugal for his PhD grant.

References

- Oliveira, F., Tavares, J.** (2009): Matching contours in images through the use of curvature, distance to centroid and global optimization with order-preserving constraint. *CMES: Computer Modeling in Engineering & Sciences* 43(1):91-110.
- Oliveira, F., Tavares, J., Pataky, T.** (2009): Rapid pedobarographic image registration based on contour curvature and optimization. *Journal of Biomechanics* 42(15):2620-2623.
- Oliveira, F., Pataky, T., Tavares, J.** (2010): Registration of pedobarographic image data in the frequency domain. *Computer Methods in Biomechanics and Biomedical Engineering*, 13(6):731-740.

Oliveira, F., Tavares, J. (2010): Novel framework for registration of pedobarographic image data. *Medical & Biological Engineering & Computing* (in press). DOI: 10.1007/s11517-010-0700-4